INDOOR AIR QUALITY REASSESSMENT

Johnson Elementary School
290 Castle Road
Nahant, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
February, 2002

Background/Introduction

At the request of Cecilia DiBella, Superintendent of Nahant Public Schools, the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality at the Johnson Elementary School, 290 Castle Road Nahant, Massachusetts. The school was previously visited on December 19, 2000 by BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) program. A letter (MDPH, 2000) and a report (MDPH, 2001) were issued which described the conditions of the building at that time. The letter described relative humidity conditions and microbial growth in the pump room; the report identified general indoor air quality issues found in the building. Both the letter and report gave recommendations concerning remediation of conditions noted in the building.

On December 5, 2001, Cory Holmes, Environmental Analyst of BEHA's ER/IAQ program revisited the school to conduct an indoor air quality reassessment. This reassessment followed the completion of most of those remedies previously recommended. Mr. Holmes was accompanied by Adrien Lemenager, School Custodian, during the reassessment.

Actions on Previous Recommendations

BEHA had previously made 16 short-term and 2 long-term recommendations to improve indoor air quality. The Nahant School Department (NSD) and Johnson Elementary School maintenance staff had implemented many of these recommendations at the time of the reassessment and these efforts should serve to improve indoor air

quality in the building. The following is a status report of action(s) taken on BEHA recommendations based on reports from school officials, documents, photographs and BEHA staff observations.

Actions on Short-term Recommendations

1. **Implement recommendations listed in previous BEHA correspondence (MDPH, 2000).**

   Action Taken: A number of the recommendations listed in previous BEHA correspondence were implemented to address microbial growth/relative humidity issues in the pump room. All water-damaged materials were removed/replaced and no microbial growth was observed during the reassessment (see Pictures 1-3).

2. **Continue working with HVAC engineering firm to restore the ventilation system. Have HVAC firm fully evaluate existing ventilation components for function and determine whether they are repairable.**

   Action Taken: The school and town officials are continuing to work with both an HVAC and architectural firm to evaluate the building's heating/ventilation systems.

3. **To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of activation by classroom thermostat control.**

   Action Taken: Classroom univents do not run continuously but cycle off and on during the day as required by the thermostat. This issue is further addressed in the **Ventilation** section of this report.

4. **Reactivate restroom exhaust ventilation to remove excess moisture and odors.**

   Action Taken: Restroom exhaust vents have been reactivated. One exhaust vent was non-functional and is reportedly awaiting replacement parts.

5. **Remove all blockages from univent fresh air diffusers, return vents and exhaust vents to facilitate airflow.**

   Action Taken: Staff were instructed by the school department to remove materials obstructing airflow of univents. Adherence to this advice was apparent in most classrooms, however several areas continue to have items obstructing univents.

6. **For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, the use of a HEPA filter equipped vacuum cleaner in conjunction with wet wiping of all non-porous surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).**

   Action Taken: Custodial staff have increased wet mopping and wiping to improve dust control. The school has not purchased a HEPA filtered vacuum cleaner.

7. **Repair any water leaks and replace any remaining water-stained ceiling tiles. Examine the areas above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.**

   Action Taken: No active leaks were reported and no stained ceiling tiles were observed during the assessment.

8. **Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.**

   Action Taken: A large number of items have reportedly been removed from several classrooms to improve dust control, however a number of areas were observed to have accumulated items during the reassessment.

9. **Move plants away from univents and ensure drip pans are placed underneath plants in classrooms. Examine plants in classrooms for mold growth in water catch basins. Disinfect water catch basins if necessary.**

   Action Taken: Adherence to this advice was apparent school-wide.

10. **Acquire current Material Safety Data Sheets (MSDS) for all products that are used in the building that contain hazardous materials, including office supplies, in conformance with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (MGL, 1983).**

    Action Taken: Reportedly master copies of MSDS' are kept in the maintenance office with duplicate copies in the Nurse's office.

11. **Store chemicals and cleaning products properly and out of the reach of students.**

Action Taken: Most of the chemicals/cleaning products have been removed from classrooms, however a number of areas were observed to have cleaning products/sprays accessible to students (see Tables).

12. **Consider bringing in wasps' nest on an "as needed" basis to prevent exposure to potentially allergenic materials.**

Action Taken: Wasp's nest were removed from the building.

13. **Clean chalkboards and chalktrays regularly to prevent the build-up of excessive chalk dust.**

Action Taken: Staff were instructed by the school department to clean chalkboards. Adherence to this advice was apparent, however a few areas were observed to have accumulated chalk dust (see Picture 4).

14. **Encapsulate damaged/exposed fiberglass in former kitchen area and in the 1964-addition hallway.**

Action Taken: Fiberglass in the 1964-addition hallway was encapsulated; fiberglass in the former kitchen area was not.

15. **Store flammable materials in flameproof cabinets in a manner consistent with state and local fire codes.**

Action Taken: Adherence to this advice was apparent school-wide.

16. **Refrain from using strong scented materials in classrooms and restrooms.**

Action Taken: Adherence to this advice was apparent school-wide.

Actions on Long-term Recommendations:

1. **As previously discussed, the age, physical condition and availability of parts for the mechanical ventilation systems throughout the school should be fully evaluated by an HVAC engineering firm to determine the operational lifespan of existing equipment and/or examining the feasibility of replacement.**

   Action Taken: Action taken on number 2 below.

2. **Repair/replace missing or damaged window caulking building-wide to prevent water penetration through window frames.**

   Action Taken: In addition to the implementation of the previous recommendations, the Johnson school has contracted with an architectural firm to conduct a feasibility study to determine the facility needs of the school (e.g., roof, windows, HVAC). This information was communicated to the BEHA in a letter detailing corrective measures taken by the NSD and Johnson School personnel (Nahant, 2001). This letter is included as an Attachment.

Reassessment

Methods

Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. A visual inspection was conducted in the steam pump room for water damage and microbial growth.

Results

The school housed grades K-6. It has a student population of over 200 and a staff of approximately 40. Tests were taken during normal operations and results appear in Tables 1-4.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were elevated above 800 parts per million of air (ppm) in seven of twenty-seven areas surveyed, which is an improvement compared to the previous report. It should be noted however that several of these areas had low occupancy and/or open windows, which can greatly contribute to reduced carbon dioxide levels. The MDPH approach to resolving indoor air quality problems is generally two-fold, 1) improving ventilation to dilute and remove environmental pollutants and 2) reduce or eliminate exposure opportunities from materials that may be adversely affecting indoor air quality.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (see Figure 1). As stated previously, all univents were operable. However they do not run continuously but are activated by thermostats once room temperatures drop below a set level. When the room temperature exceeds the thermostat setting, univents deactivate. Without mechanical ventilation running continuously, fresh air cannot be introduced into classrooms on a consistent basis. Compounding this issue is lack of thermostatic control over the heating system, which the school is currently investigating with their architect and HVAC contractor.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a univent and exhaust system, the systems must also be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. It is recommended that HVAC systems be re-balanced every five years (SMACNA, 1994).

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact

that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings in occupied areas ranged from 71° F to 85 ° F, which were above the BEHA recommended range in a number of areas. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ° F to 78 ° F in order to provide for the comfort of building occupants. As explained earlier, the school is experiencing problems controlling heat flow into classrooms via the univent system. Due to excessive heat, it is not recommended that univents run continuously *until* temperature control is restored. As an example, Mr. Lemenager activated the univent in classroom 7 (which had a room temperature of 85 ° F) a temperature reading of over 133 ° F was measured directly over the univent. It is difficult to control temperature and maintain comfort without the HVAC equipment operating as designed. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 26 to 43 percent, which was below the BEHA recommended comfort range in some areas. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Conclusions/Recommendations

The Nahant School Department, working in conjunction with Johnson Elementary School staff, has improved overall indoor air quality at the school by implementing many of the BEHA's previous recommendations. While a number of issues remain to be addressed the NSD is taking steps to further remedy IAQ problems. In view of the findings at the time of the visit, in addition to those made in the previous report, the following recommendations are made to further improve indoor air quality:

1. Continue to implement recommendations made in the previous assessment.
2. Continue working with HVAC engineering firm and architects to resolve heating issues. Once heating issues are resolved, operate univents continuously during periods of school occupation, independent of classroom thermostats, to provide a constant source of outside air.
3. Use openable windows to supplement fresh air supply in the building, until control of heat is restored.
4. Continue with plans to conduct feasibility study to determine the long-term facility needs of the school (e.g., HVAC, windows, roof, drainage).
5. Consider obtaining a HEPA filtered vacuum cleaner to control for dusts.

References

BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

MDPH. 2000. Letter to Cecilia DiBella, Superintendent, Nahant Public Schools, Regarding Indoor Air Quality Issues at the Johnson Elementary School, Nahant, MA. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA. December, 2000.

MDPH. 2001. Indoor Air Quality Assessment, Johnson Elementary School, Nahant, MA. Massachusetts Department of Public Health, Bureau of Environmental Health Assessment, Boston, MA. March, 2001.

Nahant. 2001. Letter to Suzanne Condon, Assistant Commissioner, Bureau of Environmental Health Assessment from Cecilia DiBella, Superintendent, Nahant Public Schools concerning indoor air quality corrective actions taken at the Johnson Elementary School. Dated October 22, 2001.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

SMACNA. 1994. HVAC Systems Commissioning Manual. 1st ed. Sheet Metal and Air Conditioning Contractors' National Association, Inc., Chantilly, VA.

Picture 1

Areas of Pump Room Previously Contaminated with Microbial Growth

Picture 2

Areas of Pump Room Previously Contaminated with Microbial Growth

Picture 3

Steam Trap Released outside the Building, Previously Released inside the Pump Room

Picture 4

Accumulated Chalk Dust in Classroom

TABLE 1

Indoor Air Test Results – Johnson Elementary School, Nahant, MA – December 5, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	420	59	43					Weather conditions: partly cloudy, unseasonably warm
Library	587	74	39	2	Yes	Yes	Yes	
Room 5	1090	74	41	15	Yes	Yes	Yes	Univent off-cycle
Room 6	1060	74	41	22	Yes	Yes	Yes	Univent off-cycle
Room 4	950	73	40	14	Yes	Yes	Yes	Chalk dust
Room 2	1120	72	43	20	Yes	Yes	Yes	Univent off-cycle
Room 1	690	71	39	0	Yes	Yes	Yes	Univent off-cycle
Room 3	714	71	39	0	Yes	Yes	Yes	Univent on-cycle, 3 plants, window open
Room 12	674	71	41	17	Yes	Yes	Yes	Univent off-cycle, 10+ plants, window open
Computer Lab (Room 13)	706	74	41	1	Yes	Yes	Yes	Univent off-cycle
Room 11	1025	73	41	15	Yes	Yes	Yes	Univent off-cycle, 10+ plants, windows open

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 2

Indoor Air Test Results – Johnson Elementary School, Nahant, MA – December 5, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 9	948	72	41	23	Yes	Yes	Yes	Window open, univent off-cycle
Pre-school Room 8	948	73	43	34	Yes	Yes	Yes	Window open, broom, exhaust vents broke-on order, univent off cycle
Pre-school Room 10	664	73	40	7	Yes	Yes	Yes	Window open
Nurse's Office	467	71	37	2	Yes	No	No	Window open
Room 1	618	72	41	19	Yes	Yes	Yes	Window open, spray cleaner under sink, univent off cycle – radiating heat-very hot
Room 2	566	74	39	17	Yes	Yes	Yes	Window and door open, univent off cycle-radiating heat-very hot, ~10 plants
Room 3	466	76	39	1	Yes	Yes	Yes	Window open, univent off cycle-radiating heat-very hot
Room 4	622	75	38		Yes	Yes	Yes	Window open, unlabeled spray bottle under sink
Room 5	503	79	36	0	Yes	Yes	Yes	Window open, univent off cycle, 5 plants

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 3

Indoor Air Test Results – Johnson Elementary School, Nahant, MA – December 5, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Room 7	447	85	26	1	Yes	Yes	Yes	Window open, univent off cycle-*133°F directly above univent, motor replaced
Room 6	477	78	27	0	Yes	Yes	Yes	Window open, 2 univents off cycle, gal. Paint, spray cleaner under sink
McKenna	578	79	34	1	Yes	Yes	Yes	Window open, univent off cycle, power panel on order, exhaust vent deactivated by occupant-reactivated
White	510	78	34	1	Yes	Yes	Yes	
Former Computer Room – Now Storage	518	77	37	0	No	Yes	No	Outside air ducted in
Pump Room	774	91	47	0	Yes	No	Yes	Cleaned/dried, water damaged/moldy materials replaced, steam pump rerouted to outside building, all items removed
Gym	611	76	36	1	Yes	Yes	Yes	AHU off cycle

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

TABLE 4

Indoor Air Test Results – Johnson Elementary School, Nahant, MA – December 5, 2001

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Cafeteria	682	75	38	30+	Yes	Yes	Yes	Window open, exhaust on, heat off

*** ppm = parts per million parts of air**
CT = ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%